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Characteristics and transmission dynamics of COVID-19 in healthcare workers at a London teaching hospital

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S U M M A R Y

Background: Healthcare worker (HCW)-associated coronavirus disease 2019 (COVID-19) is of global concern due to the potential for nosocomial spread and depletion of staff numbers. However, the literature on transmission routes and risk factors for COVID-19 in HCWs is limited.

Aim: To examine the characteristics and transmission dynamics of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in HCWs in a university teaching hospital in London, UK.

Methods: Staff records and virology testing results were combined to identify staff sickness and COVID-19 rates from March to April 2020. Comparisons were made with staff professional groups, department of work, and ethnicity.

Findings: COVID-19 rates in our HCWs largely rose and declined in parallel with the number of community cases. White and non-White ethnic groups among our HCWs had similar rates of infection. Clinical staff had a higher rate of laboratory-confirmed COVID-19 than non-clinical staff, but total sickness rates were similar. Doctors had the highest rate of infection, but took the fewest sickness days. Critical care had lower rates than the emergency department (ED), but rates in the ED declined when all staff were advised to use personal protective equipment (PPE).

Conclusion: Sustained transmission of SARS-CoV-2 among our hospital staff did not occur, beyond the community outbreak, even in the absence of strict infection control measures in non-clinical areas. Current PPE appears to be effective when used appropriately. Our findings emphasize the importance of testing both clinical and non-clinical staff groups during a pandemic.

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Introduction

Coronavirus disease 2019 (COVID-19) in healthcare workers (HCWs) has caused understandable concern because of the risk of infection from patients, the impact on staffing levels, and the potential for hospital staff to become vectors for onward

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transmission. Reports of worse outcomes in BAME (Black, Asian and other Minority Ethnic) groups and debates about personal protective equipment (PPE) have heightened these concerns [1,2]. China, Italy and the USA have reported HCW infection rates of up to 3.8%, 10%, and 19%, respectively, with fatality rates of up to 1.2% [3–5]. Current literature for the UK is limited and is restricted to data from short time-frames with little detail on transmission dynamics, and on inter-departmental and inter-specialty differences [6,7].

On March 18th, 2020, we started testing staff for acute infection in our own institution (a London teaching hospital, employing 8738 staff). We were aware of significant numbers of infections, and sadly four staff members from clinical and non-clinical settings have died. By analysing our staff testing data, we hoped to identify patterns of transmission and risk factors for disease acquisition.

Methods

Staff testing started a week after the 'surge' in COVID-19 admissions began. Criteria for testing changed over time due to guidance from NHS England, increases in testing capacity, and a growing awareness of the range of staff being infected. Initial testing focused on front-line clinical staff, especially from the emergency department (ED) and intensive care unit (ICU). This was gradually expanded to other clinical staff, then to all staff, and finally to contractors (including cleaning and catering staff). Symptomatic staff were referred by their line managers to a drive-through testing pod. A combined nose and throat swab was taken for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) real-time polymerase chain reaction (PCR). We initially used the E and S gene target assay (Realstar®; Altona Diagnostics, Hamburg, Germany), and later replaced this with the ORF1a/b and E gene target assay (Cobas® SARS-CoV-2 assay; Roche, Basel, Switzerland). Occupational health data and staff records were combined to identify proven COVID-19 and sickness rates from March to April 2020 and analysed using Microsoft Excel™. Staff were categorized as clinical (nurses, doctors, allied health professionals, healthcare assistants) or non-clinical (administrative, non-patient facing specialties, e.g. laboratory scientists, housekeeping, estates and facilities etc.).

Results

In all, 1045 hospital staff were tested for SARS-CoV-2 infection by PCR, of which staff roles could be identified in 958 (92%), comprising 11% of overall staff numbers. SARS-CoV-2 was detected in 498 (52%). The proportion of male staff in the hospital both attending for testing and testing positive was higher than in females: 13% versus 10% ($P = 0.002$) and 7% versus 5% ($P = 0.0006$), respectively. Ethnicity data were available for 778 (81%) staff. The proportions of White and BAME staff in the hospital attending for COVID-19 testing and subsequently testing positive were broadly similar (Table I). However, there were differences within the BAME groups; in particular, a lower proportion of Black/Black British staff attended for testing and tested positive. This may be related to the differences noted in the representation of different ethnic groups in different professional groups. Just 2% of the medical/dental workforce is comprised of Black/Black British staff but they make up 9% and 16% of the nursing and healthcare assistant staff groups respectively.

Table I
Proportions of ethnic groups among healthcare workers in hospital

Group	All	Attended for testing	Tested positive for SARS-CoV-2
White/White British	51	53	51
Asian/Asian British	20	28	29
Black/Black British	17	8	9
Chinese/Other	5	4	4
Mixed race	4	4	4
Not stated	3	3	3

These values are percentages.

Infections occurred in all staff groups and in all departments in the hospital. The epidemic curves for new admissions of COVID-19 patients, COVID-19-positive staff, and staff sickness episodes are shown in Figure 1. The curves coincide closely, although absence due to illness (from any cause) in clinical staff peaked a week after that in non-clinical staff, and coincided with the peak of COVID-19 patient admissions. A possible second smaller peak in staff sickness is observed about a week after testing for all clinical and non-clinical staff was introduced. The peak of confirmed staff COVID-19 actually occurred a week before that of patient admissions.

A higher proportion of clinical staff tested positive for SARS-CoV-2 over the study period, compared to non-clinical staff groups (7% and 3% respectively). Doctors had the highest rate of proven COVID-19 at 11%, followed by nurses at 7% and healthcare assistants at 6% (Table II). Because clinical staff were initially prioritized for testing, we also examined staff sickness records. Total staff illness episodes were proportionately similar in both clinical and non-clinical groups, despite clinical staff being more likely to attribute their illness to COVID-19 (Table II). Thirty percent of staff had an episode of sick leave in March and April, accounting for 29,862 days lost, a 74% increase in sickness levels compared with the same time-period in the previous year. Despite having the highest rate of proven COVID-19; doctors had the lowest rate of overall sickness absence compared to other staff groups, at a mean of 1.4 days.

Rates of infection varied widely between clinical departments (examples of rates in selected departments are given in Table III). These data record the departments that staff are formally assigned to, but many general medical and surgical staff were rapidly assigned to newly designated COVID-19 wards and intensive care units (ICUs) during these months. Anaesthetists and theatre staff tended to be assigned specifically to COVID-19 ICUs. Front-line services (emergency and acute medicine) had considerably higher rates of proven COVID-19 than ICU and theatre staff. Confirmed COVID-19 infections also peaked earlier in the ED and acute medicine compared to other specialties (Table IV). Of note, staff infections in the ED decreased after the introduction of universal PPE in the department from March 28th. By contrast, confirmed infections peaked later in locum/bank staff.

Discussion

Limitations of our data include a lack of information on disease severity and clinical outcomes as well as the effect of staff redeployment to COVID-19 wards and ICUs. We also have less data available for contracted services, which includes many domestic and cleaning staff. The true rate of COVID-19 in different staff groups may be masked by selective and changing

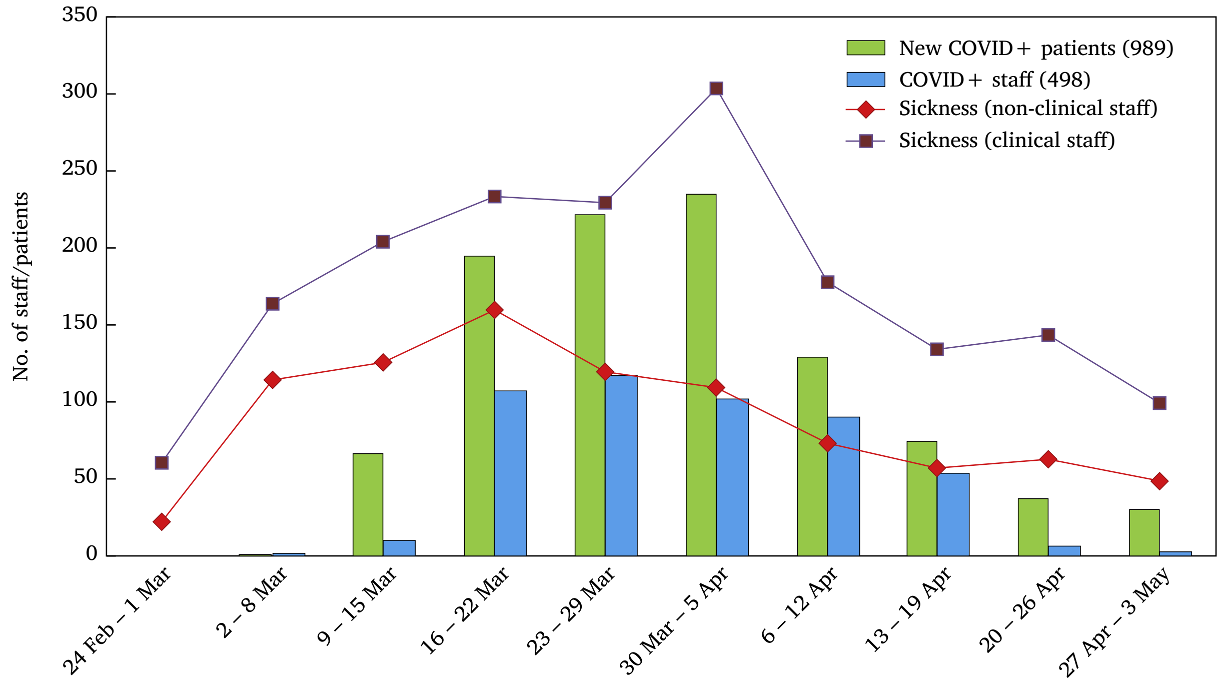

Figure 1. Epidemic curve showing weekly numbers of patients admitted, COVID-19 in staff, and total sickness episodes for clinical and non-clinical staff between February 24th and May 3rd, 2020. The dates for COVID-19-positive staff refer to the onset of illness, not the testing date. Testing of inpatients without a travel history began on March 12th. The official staff testing programme began on March 18th. The UK national lockdown began on March 23rd.

testing criteria. This was addressed by analysing overall staff sickness episodes.

When the COVID-19 pandemic began, there was global concern about the risks to HCWs and the adequacy of PPE. Front-line clinical staff were perceived to be at greatest risk, and this (along with concerns about diagnostic capacity) informed the initial staff testing strategy. However, the matching epidemic curves of confirmed staff and patient infections along with the large numbers of infections in non-clinical staff supports a community source for a significant proportion of staff. Nevertheless, the delayed peak in clinical staff sickness episodes cannot be ignored. The most plausible explanation is that at least some of the staff infections are related to patient exposure, with some transmission within individual clinical departments. Department-specific data do support a hypothesis of some localized clusters of infection (Table II). This is not surprising given viral infectivity and necessary close contact of staff in a busy work environment. The possible second smaller peak in staff sickness may represent increased detection due to widening of criteria of testing to all staff groups. Nonetheless, the fact that staff COVID-19 and sickness rates decreased rapidly through April, in line

Table II

Proportion of staff that were COVID-19 positive by polymerase chain reaction and episodes of COVID-19-specific and overall sickness in different staff groups during March and April 2020

Professional group	% of staff COVID-19 positive	Total sickness episodes per staff member	COVID-19 sickness episodes per staff member
Other professional/technical	2.8%	0.24	0.09
Additional clinical services*	6.4%	0.39	0.10
Administrative and clerical	2.2%	0.32	0.05
Allied health professionals*	3.5%	0.30	0.10
Estates and ancillary	1.6%	0.27	0.02
Healthcare scientists	4.3%	0.25	0.08
Medical and dental*	10.5%	0.19	0.11
Nursing and midwifery*	7.1%	0.31	0.10
*All clinical staff groups	7.3%	0.30	0.10
All non-clinical staff groups	2.8%	0.29	0.06

The 'Additional clinical services' group consists mostly of healthcare assistants.

Table III
Rates of COVID-19 in selected hospital directorates

Directorate	No. of staff	No. diagnosed with COVID-19
Emergency medicine	231	40 (17.3%)
Acute medicine	538	56 (10.4%)
Cardiothoracic	195	18 (9.2%)
Cardiology	271	24 (8.9%)
Renal, oncology and palliative medicine	355	31 (8.7%)
Specialist medicine (including infectious disease and respiratory)	385	33 (8.6%)
Surgery	718	38 (5.3%)
Neurosciences	616	29 (4.7%)
Pathology	493	20 (4.1%)
Diagnostics (including radiology)	425	17 (4.0%)
Estates and facilities	340	13 (3.8%)
Anaesthetics and theatres	645	23 (3.6%)
Therapies	309	11 (3.6%)
Outpatients	440	12 (2.7%)
Children's services	742	20 (2.7%)
Critical care	428	11 (2.6%)
Women's services	414	10 (2.4%)
Pharmacy	268	5 (1.9%)

with the decrease in COVID-19 patient admissions, suggests that sustained hospital transmission did not occur, despite the localized clusters, and despite the ongoing proximity of staff to each other and to inpatients with COVID-19. This is perhaps relevant to the current debate about what mandatory measures for staff are necessary to prevent and manage possible future epidemics of COVID-19 in hospitals.

We found no evidence of greater acquisition of COVID-19 among BAME staff, as the rates reflected overall staff proportions. Although staff ethnicity data were incomplete, it was available for more than 80% of the staff data analysed and therefore we feel it was unlikely to have influenced this observation. However, we were unable to gather data on disease severity or staff hospital admissions. The underrepresentation of Black/Black British staff attending for testing was surprising, and may have been due to the different representation of ethnic minorities in certain staff groups, leading to differential access to testing, especially early in the local epidemic.

The testing data and overall sickness rates yielded conflicting results for clinical and non-clinical staff groups. This may partly be because non-clinical staff had reduced access to testing. It may also reflect varying pressures around taking sick leave — particularly among doctors, who had the least documented sick leave, despite having the most confirmed COVID-19 cases. Infected but mildly ill staff members may be tempted to continue working (especially if their roles are highly specialized and cannot be easily covered by a colleague), thus posing an ongoing transmission risk [8]. It is important to provide access to testing across all hospital staff groups, as, despite being denoted 'non-clinical', many employees (e.g. domestic staff) work in clinical areas and access communal areas. Testing all staff groups has crucial infection control implications as it allows detection of infectious workers, and can enable non-infectious colleagues to return to work. Furthermore, unequal access to testing may lead excluded staff groups to feel undervalued.

Earlier peaks in staff COVID-19 infections in acute medicine and the ED compared to other specialties are likely to reflect those services being the first point of contact for patients but also that testing was prioritized for frontline services early in the epidemic. The later peak in locum/bank staff may be partially explained by these staff being employed later in the pandemic as demand for staffing increased due to the surge in COVID-19 admissions. They may have also had increased exposure from working in different healthcare settings and institutions.

Among HCWs who were consistently able to access testing, rates of positive test are higher for ED and acute medicine than for ICU. ICU is often regarded as the highest-risk working environment, with a higher frequency of aerosol-generating procedures. This finding is consistent with national statistics on deaths in HCWs [9]. It is tempting to attribute this simply to the enhanced PPE that is routine in ICU, but other possibilities must also be considered. ED has a more hectic and cramped working environment; many COVID-19 cases (especially early in the surge) would be initially unrecognized; staff would alternate working in COVID-19 and non-COVID-19 designated areas. Patients attending ED may be earlier in their disease course, with higher levels of virus shedding, and generally are not ventilated, whereas those admitted to intensive therapy unit are usually more than seven to ten days into their illness with much reduced infectivity [10]. When PPE was mandated for

Table IV
Weekly numbers of confirmed COVID-19 in selected clinical departments from March to April 2020

Week beginning	Acute medicine	Emergency department	Cardic services	Anaesthetics and theatres	ITUs	Locum/bank
02.03.20	0	1	0	0	0	0
09.03.20	2	2	0	1	0	0
16.03.20	8	12	7	2	3	6
23.03.20	8	11	7	8	5	3
30.03.20	7	7	10	6	1	12
06.04.20	6	3	8	2	1	8
13.04.20	6	4	7	3	1	9
20.04.20	0	0	0	1	0	2
27.04.20	0	0	0	0	0	2
04.05.20	0	0	0	0	0	0

staff in all clinical areas of ED, the rates of COVID-19 decreased (Table IV).

In conclusion, these results have shown that all staff groups are at risk of COVID-19 with rates generally reflecting community patterns of transmission, although front-line clinical staff may be at increased risk. Sustained spread of COVID-19 among staff, beyond the peak in community cases, did not occur. Differences in rates of confirmed infections among hospital departments and professional groups may in part be due to differential access to testing: thus it is important that in future there is equality of access to testing for all staff, including those whose employment may be contracted out to the private sector such as domestic staff. There needs to be early recognition of possible cases in acute settings, with an emphasis on universal application of diligent basic hygiene and PPE. There also needs to be clarity about when staff should go off sick, with sufficient support to ensure that work is cross-covered safely, so that staff do not continue to work with mild symptoms and risk transmitting COVID-19 to other colleagues or patients.

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Conflict of interest statement
None declared.

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